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REDESIGN OF THE M577 FUZE TRIGGER ASSEMBLY

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The objective of this program was to decrease the cost of the M577 fuze trigger assembly by reducing the number of parts. The functions of the safety plate and release lever were combined into one part by adding a tail and a notch to the current safety plate. After the development program was underway, the design of the fuze was changed to the inertial point detonating fuze which resulted in the M577A1 fuze. The proposed redesign of the trigger assembly is not compatible with this inertial point detonating fuze. Therefore, this development was discontinued before final testing was performed.

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INTRODUCTION

The objective of this task was to decrease the cost of the M577 trigger assembly by reducing the number of parts. Specifically, the feasibility of combining the functions of the safety plate and the release lever into a single part was investigated. The design requirements were 30,000 g setback acceleration with 30,000 RPM spin. The following requirements of the trigger assembly drawing were also retained:

1) Detent assembly shall not arm or release firing arm assembly at 1,000 RPM maximum. Detent assembly shall arm and release firing arm assembly at 2,000 RPM minimum.

2) Firing arm assembly shall not release the following at dimensions indicated:

   A. Safe separation release assembly - 0.566 R maximum.

   B. Firing safety plate assembly - 0.630 R maximum.

3) Firing arm assembly shall release the following at dimensions indicated:

   A. Safe separation release assembly - 0.596 R minimum.

   B. Firing safety plate assembly - 0.680 R minimum.

DISCUSSION

The M577 fuze trigger assembly uses two separate subassemblies to retain the firing pin and the SSD interlock pin. The safety plate assembly retains the firing pin, and the safe separation release assembly retains the SSD interlock pin.

The proposed design replaces these two subassemblies with a single assembly. This assembly uses the current safety plate shaft and a modified safety plate. The portion of the safety plate used to retain the firing pin remains the same, but a tail has been added to the plate to secure the SSD interlock pin and a notch to engage the firing arm shaft. The notch has been added to the edge of the safety plate engaging the firing arm shaft, so when the plate rotates to release the interlock pin, the notch in the plate catches the firing arm shaft. Thus, the firing pin is held by the safety plate after the interlock pin is released.

In the fully safe position the firing pin and interlock pin are held by the combined safety plate. Upon release of the interlock pin, the safety plate rotates about 13° until the edge of the notch in the plate hits the firing arm shaft. Three seconds later, the firing arm shaft rotates enough to allow the safety plate to pass through the "D" of the firing arm shaft, thus freeing the firing pin. The requirements in Notes 6, 7, & 8 of Part No. 9236603 are retained (fig. 1). Figures 2, 3, and 4 show the design in the three possible positions.

The combined safety plate is the same thickness and material as the current safety plate. The shaft used with the combined safety plate is the same shaft used in the current safety plate assembly. Changes required for three parts are:

1) Pivot hole and pad for safety plate assembly in the trigger spacer is relocated .062 in. from the current location. The pad and pivot hole for the release lever assembly are eliminated.

2) Pivot hole for safety plate assembly in the bottom plate is relocated .062 in. from the current location. Pivot hole for release lever assembly is eliminated.

3) Length of the SSD interlock pin is increased by .065 inches, because the combined safety plate is further from the SSD than the current release lever.

Prototypes of the combined safety plate were made using the electrical machining discharge process and secondary operations. The bottom plates and trigger spacers were modified from current production parts. Interlock pins were cut to the increased length using the present production wire.

Trigger assemblies were built with these prototype parts and tested satisfactorily at 1,000 and 2,000 RPM. The sequential trigger function inspection per Drawing No. 9236603 was performed with acceptable results.

Additional testing was performed to measure the safety factor of the lock on the SSD interlock pin. Two safety plates were modified by removing .005 and .010 in. of material from the tail. Three units were tested at 30,000 and 6,000 RPM for safety. The safety plate with .010 in. of material removed allowed the interlock pin to release the SSD 6,000 RPM. The safety plate with .005 in. of material removed allowed the interlock pin to release the SSD at 30,000 RPM, but at 6,000 RPM the interlock pin was contained in the safe position. However, the unit with no material removed from the safety plate passed both the 6,000 and 30,000 RPM safety test.

After these tests, it was decided to build a simple compound die to make the combined safety plate and to modify an obsolete die for the trigger spacer to relocate the pad for the safety plate. Fuzes made with these parts were built and air gun and ballistically tested. The air gun tests were successful; however, in the ballistic testing, safety failures occurred.

Tolerance studies were performed after this ballistic test to determine if this design concept could be revised to make it workable with the M5"7 trigger assembly, as well as with the M577A1 fuze. The first study initiated was to examine the maximum amount of deflection of the interlock pin in the direction that would cause the pin to become disengaged from the safety plate.

An analytical study was done, in which hole sizes and tolerances, part sizes and tolerances, and position tolerances were combined to produce tilting of the interlock detent and pin assembly with respect to the SSD spacer in which it is mounted.

Use was then made of a large scale graphical layout of the trigger on which nominal locations and sizes of holes and nominal sizes of parts were shown. For nominal locations, this layout showed an engagement of .037 inches between the edge of the detent pin and the end of the hook of the combination safety plate. Applying the deflection from the analytical study to the graphical layout shows this engagement to be reduced to .018 in.

Any possible additonal deflection of the detent pin due to misalignment of pin holes between trigger plates and/or spacer was not accounted for in this study, nor was additional deflection due to forces generated by spin examined.

This study indicated the design was marginal and could possibly be made workable with the M577 fuze by making some changes to the safety plate. However, it was decided the longer interlock pin in the M577A1 permitted too much tilt for this design concept to be acceptable.

A redesign of the combined safety plate for the M577 fuze was investigated. The hook on the safety plate used to hold the interlock pin was changed to increase the lock on the pin. The diameter of the firing pin was increased in order to have a greater angle of rotation when the interlock pin is released, and the firing pin is still engaged.

A small quantity of trigger assemblies with the redesigned combined safety plate and the standard firing pin were built and tested. The standard firing pin was used in order to save time and because this represents a more sever case than the proposed design.

Laboratory tests were conducted with trigger assemblies containing redesigned combined safety plate assemblies. Five units were statically tested to see if the SSD interlock pin would remain engaged in the trigger when a load equivalent to 30,000 RPM is put on the interlock pin. In all five units, the interlock pin remained in the safe position.

The same five units were then built into inert fuzes and spin tested at 15,000 RPM. All units were set for shipping, then spun at 15,000 RPM for a minimum of 20 seconds. All SSD's remained in the safe condition with the interlock pin remaining engaged in the trigger.

To verify that the trigger assemblies would operate per drawing, the inspection required in the notes of the trigger assembly drawing was performed on the same five units. All five units passed.

These tests indicate that the combined safety p.ate concept may be a feasible replacement for the former design. Additional spin tests and ballistic tests would be required. However, this design concept is not compatible with the M577A1 fuze because of the lengthened interlock pin in the M577A1 design. Because of this incompatibility, it was recommended that development of the combined safety plate concept be discontinued.

TESTING

Air-gun Test

Ten fuzes with the original redesigned trigger assemblies were air gun tested at 25,982 to 31,991 g's. One unit was destroyed due to a malfunction of the air gun. The setback pins in the triggers were removed after the test so the triggers could be spin tested. Seven of the nine units passed the 2,000 RPM under 600 pounds load test, including two units with broken sleeves. Of the two units that did not pass the test, one had a jammed firing arm caused by a broken sleeve, and the trigger in the other unit had already fired. Upon recycling, this unit successfully passed the 2,000 RPM test. These results compare favorably with the results of the standard fuze after air gun testing.

Ballistic Test

Sixty fuxes, with the first redesigned trigger assembly, were ballistic tested for feasibility at Yuma Proving Grounds. Results of these tests showed the design is reliable, but does not provide the required safety. Safety failures occurred when the fuzes were set on the shipping setting. This test was designed to determine if the combined safety plate would retain the SSD interlock pin under high spin in a ballistic environment. Results of the 8", Zone 1 test show the reliability of the combined safety plate is adequate in a low spin environment. A summary of the ballistic results is shown in table 1 below.

Table 1. Ballistic test results

No. of units	Gun	Zone	Time (sec)	Env (°F)	Function	Mean time	Std dev
20	8-in. M2A1E1	1	15	70	19/20	15.014	0.052
20[a]	8-in. M2A1E1[a]	1	15	70	20/20	14.977	0.055
20[b]	105-mm M103[b]	7	94 (shipping setting)	TV-70	12/19		
3[c]	105-mm M103	7	94	70	1/3		

[a] Controls.
[b] Two missed board but did not function on ground impact.
[c] Test stopped after first function.

CONCLUSIONS AND RECOMMENDATIONS

Laboratory tests of the final design of the trigger combined safety plate indicate this concept may be a feasible replacement for the former design in the M577 fuze. Since this design eliminates a two part assembly, it would reduce the cost of the trigger assembly. The estimated cost savings at the beginning of the development was $.28 per fuze excluding general and administration costs and profit. Before this design could be implemented, additional development and testing would be necessary. However, this design is not compatible with the M577A1 fuze. Since the M577 fuze is being phased out of production, it is recommended that further development and testing of this concept be discontinued.

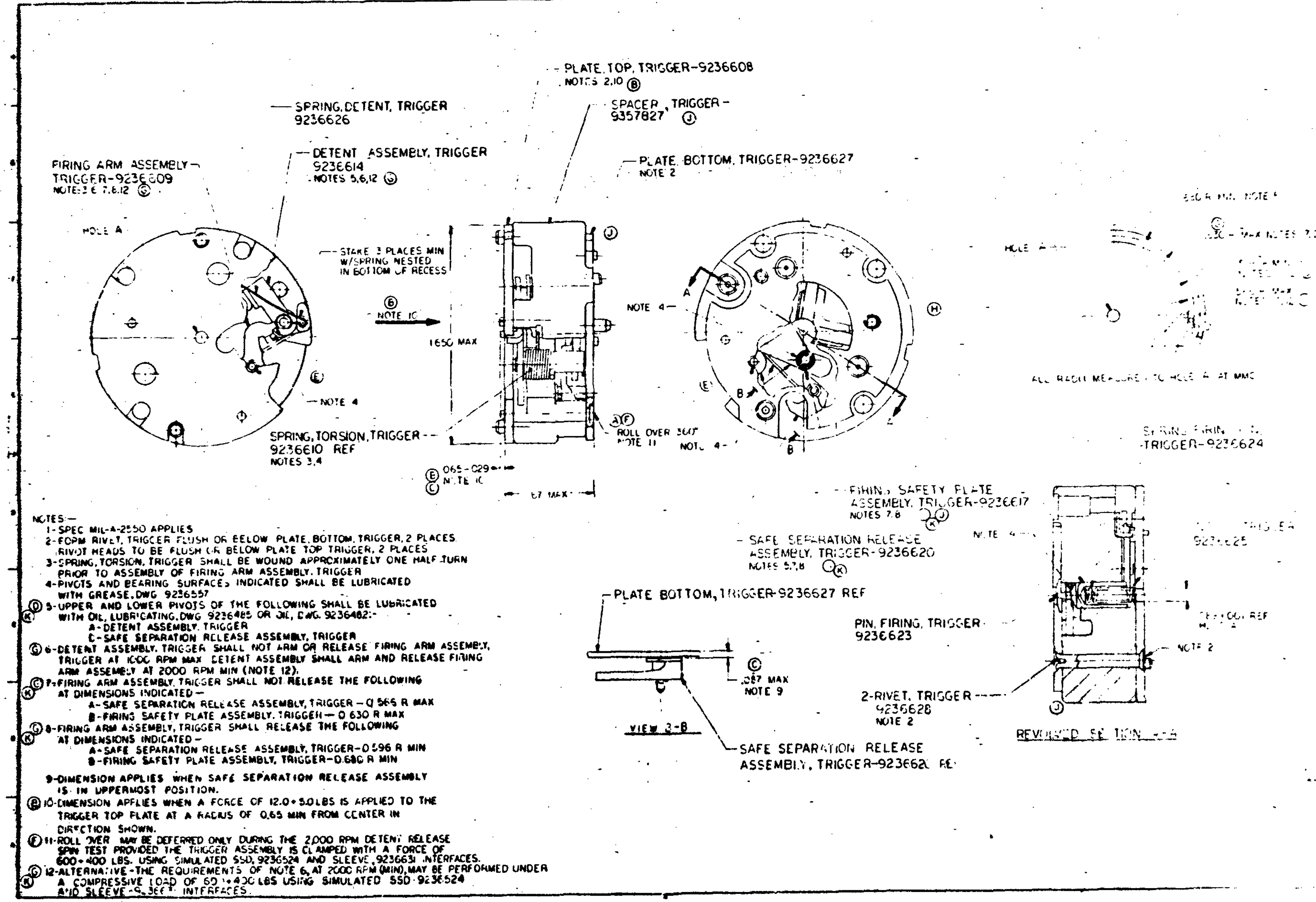

Figure 1. Trigger assembly

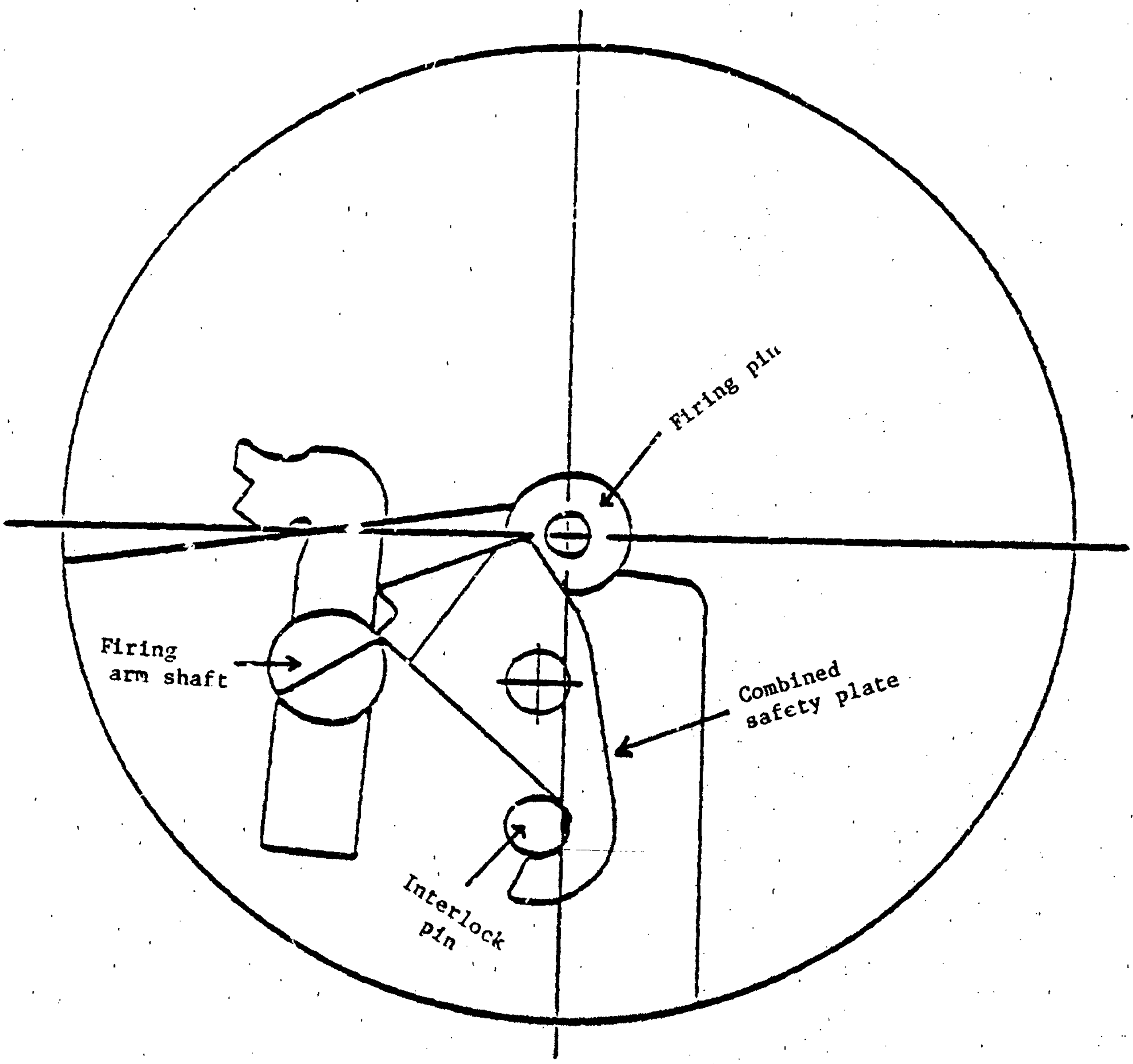

Figure 2. Safe position

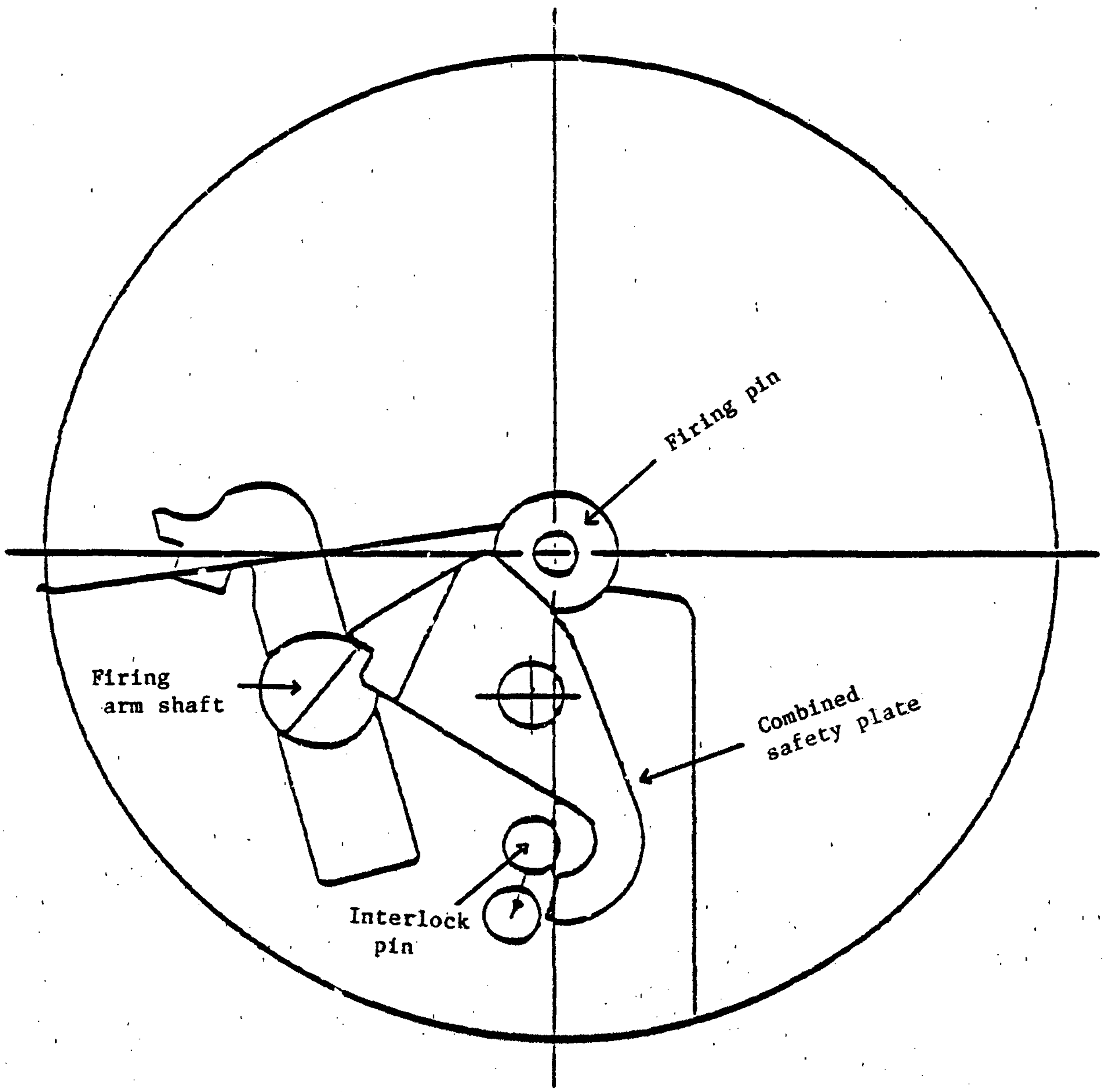

Figure 3. Safe separation device (SSD) interlock releases (position 2)

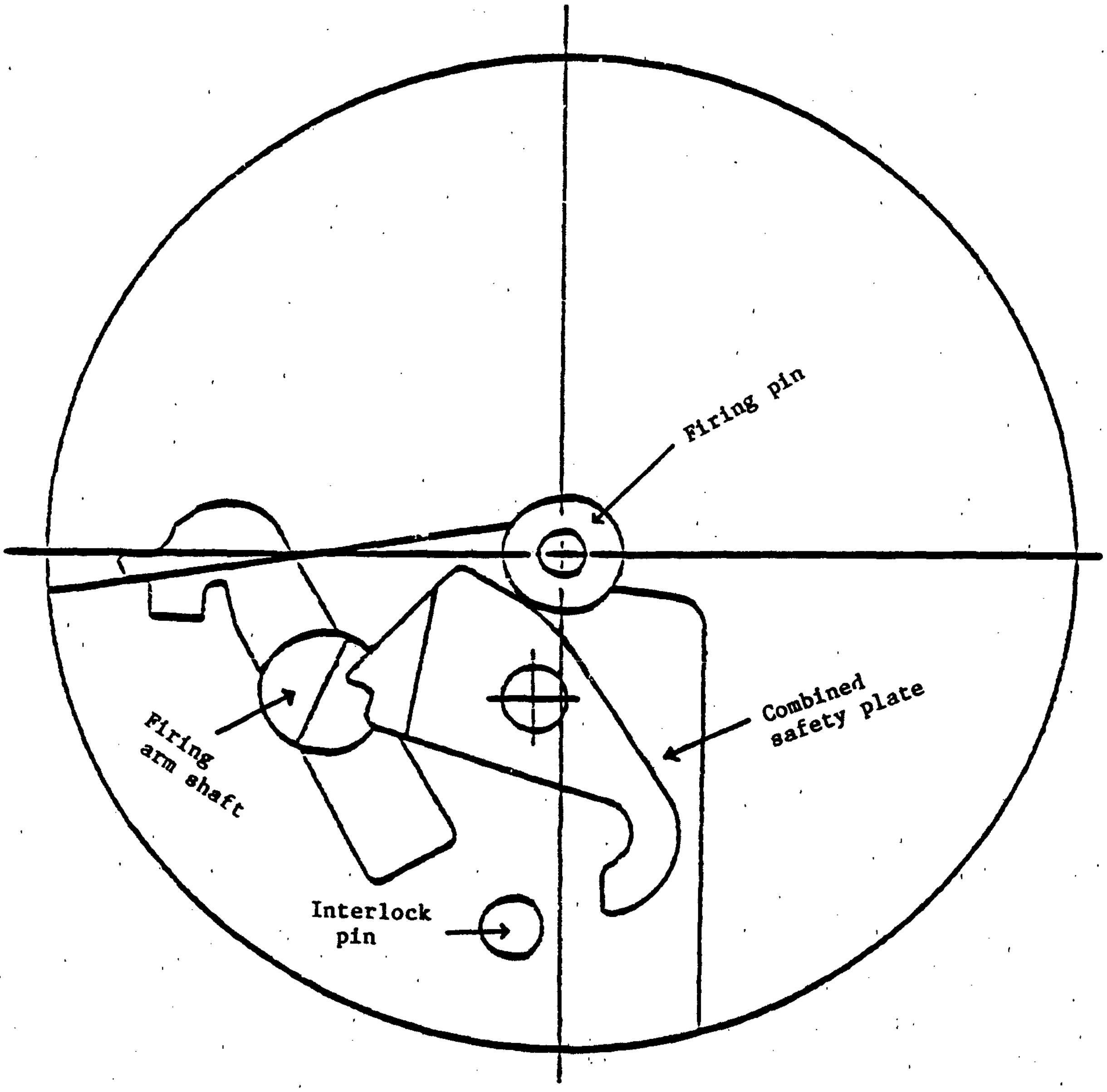

Figure 4. Firing pin released (position 3)

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